



SCIENTIFIC PROGRAM

for
implementation of activities under the MASRI project

from

Consortium "Infrastructure for Sustainable Development of Marine Research and Participation in the
European infrastructure EURO-ARGO – MASRI,

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INTRODUCTION

INFRASTRUCTURE FOR SUSTAINABLE DEVELOPMENT IN THE FIELD OF MARINE RESEARCH AND PARTICIPATION IN THE EUROPEAN INFRASTRUCTURE EURO-ARGO – MASRI is a project part of the National Roadmap for Scientific Infrastructure (2020-2027) of the Republic of Bulgaria.

The mission of MASRI is to build and use a modern scientific infrastructure that will provide the basis for highly effective marine research, to expand our knowledge of the marine environment and to support blue growth and the implementation of maritime policy and maritime spatial planning, to achieve UN Sustainable Development Goal 14: Protect and sustainably use the oceans, seas and marine resources for sustainable development.

IARI is a large-scale, interdisciplinary, multifunctional (physics, chemistry, biology, geology, aquaculture, medicine, energy, underwater and ocean technology) marine research infrastructure of great scientific importance and will provide unique facilities (including databases and computer network) that will be widely available at national, regional and international level for multidisciplinary marine research.

MASRI plans both a significant modernization of existing unique resources and equipment, as well as the creation of new facilities. MASRI consists of four modules:

- I. Research Navy;
- II. National Operational Maritime Observation System – NOMOS;
- III. Data and Information Center;
- IV. Research laboratory complex.

Each module is a functionally separate part of the scientific infrastructure, consisting of physically distributed components located in different scientific organizations within the city of Varna. Varna.

The infrastructure is being built by a consortium of scientific institutes and universities consisting of:

INSTITUTE OF OCEANOLOGY AT THE BULGARIAN ACADEMY OF SCIENCES (IO-BAS) – Coordinator

SOFIA UNIVERSITY "ST. KLIMENT OHRIDSKI" KL. OHRIDSKI" (SOFIA UNIVERSITY)

NATIONAL INSTITUTE OF METEOROLOGY AND HYDROLOGY (NIMH)

CENTER FOR HYDRO- AND AERODYNAMICS AT IMSTCA-BAS (BSHC-BAS)

INSTITUTE OF FISHERIES RESOURCES, FSA (IRR-AA)

NAVAL SCHOOL "N. Y. VAPTSAROV" (NAVAL ACADEMY)

TECHNICAL UNIVERSITY OF VARNA (TU-Varna)

MEDICAL UNIVERSITY – VARNA (MU-Varna)

This Scientific Program is an updated version of the Scientific Program developed in 2019. taking into account the objective realities related to the insufficient funding of the National Roadmap for Scientific Infrastructure (2020-2027) of the Republic of Bulgaria. It consists of formulated Tasks/Topics that will be implemented with the help of the newly created/modernized scientific infrastructure, emphasizing its contribution to the progress of the partners' research activities.

Our experience of nearly eight years of work on the MASRI project with insufficient funding for its full implementation has shown that it is necessary to prioritize in deciding which infrastructure should be developed with priority and the scientific program mainly includes those infrastructures that are developed as a priority.





Work team

This scientific program has been developed with the participation of scientists from all partners, as follows:

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MEDICAL UNIVERSITY – VARNA (MU-Varna)

Prof. Dr. Dimitar Stavrev





MODULE I. Research Fleet

1. Research vessel of regional class "Academic" - IO-BAS

SCIENTIFIC TASK 1. Collection of oceanographic data and maintenance of observation systems

Motivation

The research vessel of BAS "AKADEMIK" is a multi-purpose research vessel with an unlimited navigation area, equipped with systems and devices that allow it to perform almost all types of marine scientific research. According to the European classification, the NIK "ACADEMIC" is of a regional type. The ship was built in 1979 and has been in operation as a research vessel since 1984. In 1988 it was reconstructed and brought in line with the modern ideas of a research vessel. For 40 years, NIK "Akademik" has been the main scientific infrastructure with the help of which the state of the Black Sea was studied, with a focus on the Exclusive Economic Zone of the country. It also carries out the monitoring of marine waters in accordance with the Rachkov Water Directive (WFD) and the Marine Strategy Framework Directive (MSFD) of the European Union. It also performs the task of lowering water of Argo buoys under the BulArgo program and servicing of buoys from Module II.

Specific tasks/activities

- Service of the Argo program – lowering water on Argo buoys.
- Implementation of WFD and MSFD monitoring
- Implementation of scientific expeditions in the Exclusive Economic Zone of the country in the Black Sea.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The activities of the tasks performed by NIK "Akademik" are related to Module II. NOMOS and to MODULE IV. Research laboratory complex, in particular the following laboratories, in which the samples collected with the help of the ship are processed:

- Marine Chemical Laboratory – IO-BAS
- Laboratory of Marine Biology and Ecology – IO-BAS
- Marine Geological Laboratory – IO-BAS
- Laboratory of Marine Genetics – IO-BAS

Scientific results and indicators





Challenge	Indicator	Number
1	Argo Program Service	10
	Scientific expeditions conducted	35
	Implementation of WFD and MSFD monitoring	20
	Promotion of the achievements of NIC "Academic" among the public	4
	Training of specialists: Trainees	100
	International expeditions	2



2. Small Research Vessel "Explorer 2" – IO-BAS

Due to insufficient funding, the construction of this scientific infrastructure has not begun, which is why no scientific program has been developed for it.





3. Boat for underwater research and technological operations – Naval Academy

SCIENTIFIC TASK 1.

Providing a mobile platform for underwater research, technological operations and marine engineering in the coastal area.

Motivation

The growing needs of the blue economy, the development of offshore industry and the maintenance of coastal infrastructure require specialized vessels. The boat for underwater research and technological operations of the Naval Academy will provide the necessary mobile platform for conducting full-scale tests of new underwater technologies, servicing measuring systems and inspection of the seabed. In the context of modern environmental challenges, the platform will also be used for field research and full-scale tests of innovative systems, including the integration of hydrogen and oxy-hydrogen installations to reduce emissions in maritime transport.

Specific tasks/activities

- Underwater inspections of coastal and port infrastructure and seabed survey;
- Providing a platform for launching, retrieving and servicing autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs);
- Conducting practical training, safety on diving descents and testing practices related to the development of diving documentation;
- Real-world testing of engineering solutions for hydrogen integration in the propulsion complexes of small vessels;
- Support for the deployment and maintenance activities of the Module II systems (NOMOS).

The main activity of which of the 4 modules envisaged (I, II, III, IV) also includes connection with the other panels, planned equipment or other infrastructure

The activities of the boat are directly related to Module IV (Laboratory of Underwater Technologies - Naval Academy, Laboratory of Underwater Cutting and Welding - TU, Laboratory of Marine Medicine - MU) and Module II (NOMOS) for logistics and maintenance of measuring equipment.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	2





4. Research submarine PC-8B – IO-BAS

Due to insufficient funding for the MASRI project, the modernization of this scientific infrastructure has not been carried out, which is why a scientific program for it has not been developed.





MODULE II. National Operational Marine Observing System – NOMOS

1. BulArgo – IO-BAS

SCIENTIFIC TASK 1. Data collection and analysis under the BulARGO program

Motivation

Argo is the most important *in situ* ocean observation system needed by the Marine Environment Monitoring System. Nearly 4,000 autonomous profiling probes across the world's oceans measure in real time the temperature and salinity in the 0-2000 m layer.

BulArgo (<https://www.bulargo.io-bas.bg>) is a national marine infrastructure for *in situ* observations in the Black Sea, which is a component of the Euro Argo (<https://www.euro-argo.eu/>) network, built and operated by a consortium consisting of: Institute of Oceanology-BAS, Sofia University "St. Kliment Ohridski" and the National Institute of Meteorology and Hydrology.

BulArgo provides researchers with an indispensable set of data for studying:

- Study of long-term changes in the distribution of temperature and salinity near the surface and in the deeper layers;
- Seasonal and interannual variability of the characteristics of water masses;
- Assimilation of Argo data into numerical models for the Black Sea;
- Validation of model and satellite data with Argo measurements;
- Study of the seasonal and interannual dynamics of the distribution of biochemical parameters provided by Argo buoys (BGC float)
- Study of the dynamics of oxycline and the oxygen-free layer of the Black Sea;
- Obtaining new information about the deep-sea circulation in the Black Sea;
- Study of the effect of water masses from the Bosphorus on the dynamics of the Black Sea.

Specific tasks/activities

1. Study of the work of ARGO probes in relation to the specifics of the Black Sea with an emphasis on the wider use of probes with dissolved oxygen sensors and biogeochemical sensors.
2. Study of long-term changes in the distribution of temperature and salinity near the surface and in the deeper layers;
3. Validation of satellite data obtained from the sensors SMOS, AMSR-E, Aquarius, Sentinel 3A/OLCI, AVHRR, MODIS, etc. for temperature (SST) and salinity (SSS) in the surface layer with Argo measurements;
4. Study of the seasonal and interannual dynamics of the distribution of biochemical parameters provided by Argo buoys (BGC float) together with colleagues from the Chemistry and Marine Biology sections.
5. Expanding the scope and contribution of Bulgaria to monitoring the The World Ocean.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The activity on the BulArgo task belongs to Module II. NOMOS





Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	1
	Making maps	10
	Improved monitoring programs	1
	Promoting the Argo program among pupils and students and citizens	10
	Training of specialists: Argo technologies and management of the received Argo	2
	New disciplines of study	1



2. System for Observations of Waves and Currents – IO-BAS

SCIENTIFIC TASK 1. Collection and analysis of data on sea waves and currents

Motivation

Knowledge and observation of sea waves in the coastal zone is a major factor in ensuring the safety of coastal infrastructure, transport and sustainable development of tourism and economic activity. Planning of future coastal infrastructure and last but not least adaptation to climate change also require reliable and complete information about the characteristics of sea waves. Modeling and forecasting of wave processes need in situ data, for assimilation into models and verification of forecasts. The system for monitoring waves and currents will provide data on sea waves and surface sea currents in the coastal zone. Waves and currents in the sea are factors that are essential in the implementation of all maritime activities. The system will provide data and products for the needs of scientific research, coastal construction, shipping, tourism and other maritime activities.

Specific tasks/activities

Construction of a system of anchored buoys to measure sea waves.
Development of a system for collecting and storing data.
Processing and analysis of sea wave data.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The activity on the task belongs to Module II. NOMOS. It is also related to the task of Building a network of anchored hydrometeorological buoys. The collected data will be stored in the NCDI - Module III and published in real time on the Internet.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	1
	Marine Wave Database	1
	Trained specialists for maintenance and operation of the system	5
	Number of anchored buoys installed	4



3. Sea Level Monitoring System – IO-BAS

SCIENTIFIC TASK 1. Collection and analysis of sea level data

Motivation

According to a decision of the Council of Ministers, in 2012 the marine stations in Varna, Irakli, Burgas and Ahtopol are jointly managed by the Bulgarian Academy of Sciences and the Agency of Geodesy, Cartography and Cadastre. In 2012, high-precision microwave instruments were installed in the port of Varna and the port of Burgas, which can provide data in real time. In 2019, an agreement was signed between the GCCA, the IO-BAS and the National Institute of Geophysics, Geodesy and Geography-BAS for cooperation in the modernization and maintenance of the national network of sea level stations. In 2024. The agreement was updated by identifying seven coastal stations included in the national tideography network. Sea level data are important for the study of climate change, offshore economic activities and marine geo-hazards. Shipping, ports, maritime activities and coastal construction need this data.

Specific tasks/activities

1. Development of procedures for quality control of sea level data.
2. Analysis of long-term and short-term changes in sea level.
3. Study of the dynamics of the coastline and the sea-land border.
4. Technological renovation of sea level measurement stations.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The activity on the task belongs to Module II. NOMOS. The collected data will be stored in the NCCID - Module III and published in real time on the Internet.

Scientific results and indicators

Challenge	Indicator	Number
1	Procedures for quality control of sea level data	1
	Publications in international scientific journals with impact factor	2
	Making maps and diagrams	2
	Number of upgraded sea level measurement points	5

4. Network of anchored buoys – NIMH





SCIENTIFIC TASK 1: Collection and analysis of data from a network of anchored hydrometeorological buoys along the Bulgarian Black Sea coast.

Motivation

The Bulgarian Black Sea coast is 354 km long. The Black Sea is the eastern border of Bulgaria, and the sea coastal zone is of particular importance for coastal regions. Knowledge and monitoring of weather phenomena in this area is a major factor in ensuring the safety of coastal infrastructure, transport and sustainable development of tourism and economic activity. The protection of the purity of the marine environment, quality planning of the future infrastructure and last but not least adaptation to climate change also directly use the results of the work of marine meteorologists. With the development of technology, the dependence on weather conditions of human economic activity (in its various dimensions) is not decreasing, but is increasing.

Ensuring quality meteorological and oceanographic services is of key importance for all these areas of dependence. It is very difficult if there are no reliable meteorological measurements at sea (wind, temperature, humidity, etc.) and measurements of the state of the sea (elements of waves, direction and speed of currents, etc.). Existing satellite observations do not provide for the accumulation of continuous series of measurements over time and are not accurate for the processes developing in the coastal zone (up to 10 km from the coast).

At present, there is a lack of continuous series of objective measurements of the meteorological elements of the marine environment, which greatly hampers a number of activities in the Black Sea and worsens the quality of meteorological forecasts and the quality of the marine meteorological information provided for the needs of shipping, citizens and institutions.

The above-mentioned circumstances require the construction of a network of meteorological measuring instruments in the Bulgarian Black Sea to ensure continuous measurements in the marine environment, and to provide information not only to the local meteorological services, but also to the data required by the World Meteorological Organization (WMO) for international exchange. No Black Sea country has built such a network. As an EU member state, the Republic of Bulgaria can be a leader in this field and provide a good prospect for the development of its Black Sea region.

Specific tasks/activities

- To ensure instrumental, automatic and continuous year-round reporting of the meteorological elements of the air and the marine environment in the coastal zone (inland sea waters) along the entire length of the Bulgarian Black Sea coast by building a network of anchored sea buoys;
- To build communication and a system for storage, processing and visualization of the data from the established network;
- To ensure the maintenance and, if necessary, repair and improvement of the built system for a period of at least 5 years;
- To prepare and develop the necessary specialists and researchers to work with the system, with the accumulated data, their analysis and visualization;
- Based on the analysis of large numbers of accumulated data, to develop methodologies and adjust models to improve the prediction of extreme events and forecasts of weather conditions in the coastal zone (inland sea waters);
- Develop the necessary services for the business sectors:





- Energy projects related to marine phenomena and climate;
- Sea transport in the coastal area;
- Maritime security and rescue;
- Fisheries and marine crops;
- Marine facilities and shore facilities;
- Tourism and services related to the coastal area;

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity refers to Module II - NOMOS and has links with the other activities of this module and modules I - Research Fleet, III - Data and Information Center, IV - Research Laboratory Complex: Marine Chemical Laboratory and Laboratory of Marine Biology and Ecology.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	1
	Making maps of various hydrometeorological parameters	6
	Improving sea wave and wind modeling processes on the sea surface.	1
	Established system for instrumental observations	6
	Developed methodology for forecasting extreme phenomena	1
	Database of instrumental marine hydrometeorological observations	1
	Improved monitoring programs	1
	Trained PhD students (other specialists)	1

5. Coastal Research Bases – IO-BAS

SCIENTIFIC TASK 1. Coastal research , data collection and training

Motivation

Scientific Research Base "Shkorpilovtsi"

The Shkorpilovtsi Research Base is located on the sea coast near the village of Shkorpilovtsi, 50 km. south of Varna. Its construction began in 1980 and was officially put into operation in 1983. The laboratory building provides the necessary laboratories, residential and office premises and a conference hall with work opportunities for 35 people. The overpass is 230 m long and 7 m high and serves as a platform for installing research equipment. The base is used for conducting scientific research in the coastal area, training specialists and conducting scientific conferences and seminars. The base has Internet access and permanently installed equipment: a sea level meter and an automatic





weather station mounted on the overpass and an ultraviolet index meter. Numerous international scientific experiments have been conducted on the base.

Maslen Nos Research Base

The Maslen Nos Research Base was established in 1973 and is used by the Institute of Environmental Protection for research in various areas of marine science. Its geographical location and natural resources are especially suitable for various underwater activities. Expeditions are held annually, the purpose of which is to update the data related to the processes in the sea and the coastal zone, test new diving equipment, train and improve the qualification of diving teams. The base is also used as a testing ground for oceanographic instruments, for monitoring hydrochemical parameters of sea water, for training and training of deep-sea divers, training of students, scientists and postgraduates in the specialty "diver - researcher", conducting student practices for the study of surface and underwater sea terraces, modern dynamics of coastal landscapes and archaeological sites.

The expected users of the services of the research bases are: the members of the MASRI consortium, scientific institutes and universities from the country and abroad for training students and student practices and for conducting field research; central and local authorities, maritime businesses and citizens using the information obtained from the measurement systems; forecast providers using the information obtained from the measurement systems for assimilation into the models and verification of forecasts.

Specific tasks/activities

Shkorpilovtsi Research Base - Overhaul of the laboratory building and the overpass to ensure their safety. Construction of a secure approach to the overpass. Complete replacement of water supply and sewerage and electric. installations. Design and construction of a new electric. power supply and security system of the overpass. Delivery and installation of new measuring systems.

Research base "Maslen Cap" - Repairs of the campus to improve living conditions and safety. Delivery and installation of new measuring systems: sea level, weather station, oceanographic station.

The main activity of which of the 4 modules envisaged (I, II, III, IV) also includes connection with the other panels, planned equipment or other infrastructure

The main activity belongs to module II - NOMOS and has links with the other activities of this module and modules I - Research Fleet, III - Data and Information Center, IV - Research Laboratory Complex: Marine Chemical Laboratory and Laboratory of Marine Biology and Ecology.

Scientific results and indicators

Challenge	Indicator	Number
	New measuring systems installed	4





Challenge	Indicator	Number
1	Number of measuring systems generating data	4
	Number of training practices	5
	Number of trained specialists	20



6. Laboratory for Metrological Control – IO-BAS

SCIENTIFIC TASK 1. Metrological control of sensors

Motivation.

The laboratory is necessary to control the condition of the measurement systems and to ensure the accuracy of the collected marine data. At the moment, we do not have one, which requires more frequent calibration of the sensors of the measurement systems. For calibration, the sensors are sent to foreign laboratories.

The expected users of the laboratory's services are: members of the MASRI consortium, scientific institutes and universities from the country and the Black Sea region; state and local organizations operating marine measuring systems; small and medium-sized enterprises; maritime business.

Specific tasks/activities

- Preparation of a suitable room.
- Delivery of the necessary equipment and equipment.
- Training of service personnel.
- Metrological control.

The main activity of which of the 4 modules envisaged (I, II, III, IV) also includes connection with the other panels, planned equipment or other infrastructure

The main activity belongs to module II - NOMOS and has links with the other activities of this module and modules I - Research Fleet, III - Data and Information Center, IV - Research Laboratory Complex: Marine Chemical Laboratory and Laboratory of Marine Biology and Ecology.

Scientific results and indicators

Challenge	Indicator	Number
1	Number of calibration systems/sensors	3
	Trained specialists	2





MODULE III. Data and Information Centre

1. National Oceanographic Data and Information Center – BGODC – IO-BAS

SCIENTIFIC TASK 1. Collection, quality control, storage, access and processing of oceanographic data and information

Motivation.

BGODC is an electronic infrastructure that serves as a local portal for national and international exchange of oceanographic data and information. The main objectives of BGODC are: To collect oceanographic data and information, archive and store them and maximize their use; To improve the availability of high-quality oceanographic data and information for a wide range of users; To promote the exchange of oceanographic data and information at national and international level; To provide oceanographic services to end-users.

The BGODC is designated as a National Oceanographic Data Centre (NODC) in the context of the system of the Committee for the Exchange of Oceanographic Data and Information (IODE) of the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

The Oceanographic Data Center of the Institute of Oceanology – ODC-IO-BAS was established on June 27, 2002 as part of the Ocean Technologies Department of IO-BAS. Following a decision of the National Oceanographic Commission of September 8, 2004, ODC-IO-BAS was nominated as the National Oceanographic Data Center of Bulgaria. The Center was officially recognized as the National Oceanographic Data Center – BGODC and was included in the list of world oceanographic data centers of IODE in 2005, replacing the NIMH Center, which has been playing the role of NODC since 1985. In 2026 The National Oceanographic Data Center was renamed the National Oceanographic Data and Information Center – NODC/BGODIC.

BGODC participates in the European infrastructures for online oceanographic data exchange SEADATANET and ODINBLACKSEA, provides real-time data services for the Black Sea to CMEMS INSTAC and CMEMS BS-MFC. BGODC serves as a National Repository for Oceanographic Data and Information.

Specific tasks/activities

- Inventory of available data
- Estimate of available data volumes
- Meta data and data management
- Satellite data quality control
- Quality control of temperature and salinity data





Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

To everyone.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in write-offs with impact factor	2
	Participation in prestigious international forums	2
	Creation of an oceanographic database	2
	Production of maps of the horizontal distribution of temperature and salinity, as well as time series based on long-term <i>in-situ</i> and remote data for the Black Sea	10
	Training of specialists in oceanographic <i>in-situ</i> and remote data management	1
	Publish real-time data on the hub page	2
	Creation of an Expedition Reporting System – CSR (Cruise Summer Reports)	1
	Collection and publication of sea level data	



2. High Performance Computational Simulation Facility – BSHC

SCIENTIFIC TASK 1. Application of Static Methods and Numerical Models in the Study of Ship's Seaworthiness and Turbulent Currents

Motivation

A new wave channel is being built at CSA for coastal research, marine ecology and renewable marine energy applications. It will be equipped with a wave producer as well as a closed-loop current generation system. In order to ensure the control of generation and the realization of a combined wave-current flow, computer modeling and systematic flow simulations are necessary, and the results are validated by a specialized experiment.

In recent years, the additional resistance of the ship to waves has become particularly important after the introduction of international requirements for the energy efficiency of ships and the control of toxic emissions from maritime operations. In case of intense waves, the increase in additional resistance is related to the safety of navigation and the deterioration of maneuverability due to loss of speed.

Statistical assessments of the seaworthiness of a ship, and in particular of the additional resistance to waves, give, albeit with varying degrees of reliability, a direct estimate for a specific object. The purpose of this task is to systematize the available statistical information, on the basis of which to develop an approach to determining the additional resistance to wave movement, applicable both in the early stages of design and in the operation of the vessels.

Specific tasks/activities

- ✓ Analysis of semi-empirical methods for estimating the additional resistance of the ship, of the geometric and operational parameters on which it depends;
- ✓ Systematization and analysis of the data on the additional drag of ships and models studied in the Central Military Academy;
- ✓ Presentation of the Amplitude-Frequency Characteristics (RAP) of the ship during regular wave movement by defining characteristic points connected by straight lines;
- ✓ The operation of the piston wave product should be modeled by the method of numerical hydrodynamics, and with the help of dynamic meshing, the oscillating motion of its plate should be simulated;
- ✓ To achieve a uniform (with minimal turbulence) flow of the current in the channel and to check the potential control range of the axial velocity gradient.
- ✓ Experimental validation of the chosen solution by numerical model of numerical hydrodynamics.

The main activity of which of the 4 modules envisaged (I, II, III, IV) also includes connection with the other panels, planned equipment or other infrastructure





All modules.

Scientific results and indicators

Task 1.	Indicator	Number
1	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	1
	Computing Power Supply Equipment	1
	Built server system for forecasting through numerical procedures, algorithms and models	3
	A system for statistical assessment of the seaworthiness of the ship has been established.	1
	An algorithm and a numerical procedure have been developed to determine the additional wave resistance by semi-empirical dependencies.	1
	Trained PhD students (other specialists)	3



3. High-Speed Communication Environment – IO-BAS

SCIENTIFIC TASK 1. Providing an environment for access to data and information

Motivation

Modern technologies allow the collection and storage of a large amount of data and information. A key point is to provide fast and reliable remote access to them. For this purpose, it is necessary to provide technical access to data and information servers using modern communication equipment and technologies.

Specific tasks/activities

- Building access to data and information servers via a high-speed radio channel and fiber optic line.
- Ensuring continuity of access by duplicating the connection through different channels.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

All modules.

Scientific results and indicators

Challenge	Indicator	Number
1	Built high-speed connections	2
	Uninterrupted access to data and information servers	1



MODULE IV. Research Laboratory Complex

1. Marine Chemical Laboratory – IO-BAS

SCIENTIFIC TASK 1:

- Study of chemical composition and processes in the marine environment under conditions of anthropogenic pressure and climate change. Assessment of their impact on the ecosystem and human health.
- Study of warming, acidification of marine waters and the carbonate system.

Motivation

The scientific task is directly related to environmental protection and reduction of the risk of adverse events and natural disasters, and in particular to the specific risks to biodiversity and the functioning of ecosystems as a component of a sustainable and favorable living environment and water quality (including groundwater and marine) and their impact on the quality of life, health risk and the state of ecosystems and is in line with the thematic area of ISIS "Industry for Healthy Life and Bio-Technologies", as well as with priority "blue" technologies and the application of new methods and technologies in the sustainable use of river and marine resources.

Formulation of the scientific problem:

The aim of this study is:

Assessment of anthropogenic pressures such as eutrophication and climate change, acidification of seawater in the western Black Sea and potential impacts on the ecosystem.

Assessment of the physicochemical state of the western part of the Black Sea during the modern period. During the modern period, the ecosystem functions in an intermediate productive state – neither as minimally as in the true period, nor as abundantly productive and deteriorated as in the eutrophication period. Therefore, the state should not be misinterpreted as a sign of recovery.

Study of climate change and acidification and carbonate cycle in the Bulgarian part of the Black Sea.

Practical significance: determination of the state of the marine environment and impact on ecosystem and human health.

Specific tasks/activities:

- Maintaining the already obtained accreditation under BDS EN ISO/IEC 17025:2018 from the Executive Agency of the Bulgarian Academy of Sciences of the Marine Chemistry Major at the Institute of Marine Chemistry at the Institute of Environmental Sciences, the scope of which covers sampling of seawater and sediments, as well as analysis of the main physicochemical elements for quality, according to the WFD and the MSFD.
- Improvement of the methodology for the determination of total nitrogen and nitrates by using the acquired advanced peristaltic pump.





- Lowering the limits of methods for analysis of nutrients by using the newly purchased high-resolution spectrophotometer. This apparatus will ensure the operation and maintenance of the high quality of the results of the accredited laboratory.
- The possibility of installing a 10 cm cuvette in the spectrophotometer will serve as a basis for the development of a new direction related to the assessment of acidification of seawater in connection with climate change and anthropogenic pressure with CO₂. It is planned to introduce a new method for studying pH and studying carbon cycles in seawater.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity is related to Module IV Research Laboratory Complex - Marine Chemical Laboratory, and the activity is related to Module I - Research Fleet, Module II - NOMOS and Module III Data and Information Center.

SCIENTIFIC TASK 2:

Study of marine pollution by microplastics

Motivation

In recent years, pollution of the marine environment by litter, and in particular by plastics and their fragments, has established itself as one of the most serious environmental problems both globally and regionally. In the marine environment, plastic materials gradually degrade into microplastic particles that can persist for long periods of time in the water table, sediments and living organisms. They have the ability to spread over considerable distances and enter different levels of food chains. This poses a risk to marine organisms, to the functioning of ecosystems and, indirectly, to human health through the consumption of seafood.

The Black Sea is particularly vulnerable to the accumulation of pollutants due to its semi-closed nature, limited water exchange with the World Ocean, strong river contribution, intensive use of the coastal zone and concentration of human activities such as urbanization, tourism, shipping, fisheries and aquaculture. The Bulgarian part of the Black Sea includes a variety of coastal, transitional and shelf habitats in which microplastics can accumulate and exert pressure on organisms of varying nature and intensity.

The scientific problem is related to insufficient information on the spatial and quantitative distribution of microplastics in the different components of the marine environment, as well as limited data on their accumulation in biota and their potential passage through food chains. So far, the activities under Descriptor 10 of the Marine Strategy Framework Directive have focused mainly on macro-litter, while microplastics remain partially covered by single, pioneering research. This makes it difficult to develop reliable methodologies, indicators and monitoring programmes for assessing the state of the marine environment.

The proposed scientific task is directly related to the implementation of the MSFD, according to which good environmental status under Descriptor 10 is achieved when the quantities and properties of marine litter do not cause harm to the coastal and marine environment. In a national context, the task supports the activities for monitoring, assessment and management of marine waters carried out





by the Institute of Oceanology, as well as the development of the MASRI research infrastructure for sustainable marine research.

The fundamental significance of the task is expressed in obtaining new knowledge about the distribution, composition, size structure and accumulation of microplastics in the abiotic and biotic components of the Black Sea ecosystem. The practical significance is related to the adaptation, testing and validation of sampling and analysis methodologies; creation of a database; support of monitoring programs under Descriptor 10; risk assessment for ecologically and economically significant species; and providing a scientific basis for management decisions aimed at limiting plastic pollution.

Main objective

To create and develop scientific potential through the announcement of doctoral studies in the relevant field in order to develop and increase the research potential in the future. To study the spatial and quantitative distribution of microplastics in the marine environment of the Bulgarian part of the Black Sea, to assess the degree of their accumulation in various components of the ecosystem and to analyze their potential impact on marine organisms and ecosystem health.

Specific tasks/activities

1. Adaptation, testing and validation of methodologies for sampling, extraction, visual characterization and instrumental identification of microplastics in water, sediments and biota.
2. Determination of the quantity, size classes, shape, color and polymer composition of microplastic particles through a combination of microscopic analysis and FTIR spectroscopy.
3. Assessment of the accumulation of microplastics in the food chain, with a focus on ecologically significant and commercially used marine species, including bivalves, fish and other relevant indicator organisms.
4. Comparative analysis of pollution levels between different habitat types and areas with varying degrees of urbanisation, tourism, port activity, fisheries and river contribution.
5. Development of a database and cartographic products for the spatial distribution of microplastics in the studied components of the marine environment.
6. Development of science-based proposals to improve the monitoring programs under Descriptor 10, in particular D10C3, based on adapted methodologies in order to start the monitoring of microplastics to assess the good state of the marine environment under this criterion.
7. Promotion and scientific presentation of the results through publications, participation in international forums, training of young scientists and exchange of experience with partner scientific organizations.

The following types of activities are envisaged:

(A) Preparatory activities

- An overview of existing international and national approaches to the analysis of microplastics of different matrices.
- Development of protocols for sampling and laboratory analysis, prevention of secondary laboratory contamination.

B) Laboratory processing and identification





- Testing and selection of methods for extraction of microplastics from different matrices (water, sediment, biota).
- Identification of polymer composition by FTIR spectroscopy.

C) Data analysis and interpretation

- Quantitative assessment of microplastics by matrix and region.
- Statistical analysis of the relationships between pollution levels, habitat type, anthropogenic pressures and biological characteristics of organisms.
- Assessment of the potential ecological significance of the concentrations and polymer composition identified.

(D) Application results and dissemination

- Creation of a database and maps of spatial distribution.
- Development of recommendations for monitoring under Descriptor 10.
- Preparation of scientific publications, reports and training of doctoral students/specialists.

The main activity of which of the 4 modules envisaged also refers to connection with the other modules, planned equipment or other infrastructure

The main activity belongs to Module IV "Research Laboratory Complex", with the leading participation of the Marine Chemical Laboratory, supported by the Laboratory of Marine Biology and Ecology.

The activity is also related to Module III 'Data and Information Centre', as the results should be organised in a structured database, compatible with future inclusion in national and international marine information systems. Spatial results can be used to map pollution, to analyse high-risk areas and to support management authorities.

In infrastructure terms, the task will use an FTIR Fourier transform infrared spectrometer acquired under MASRI.

The equipment allows the identification of the polymer composition of microplastic particles, especially for larger particles over 500 µm. It is necessary to provide and maintain laboratory conditions to minimize secondary contamination: clean work areas, filtered water, glassware, metal tools, filters, laboratory dryers/chambers, microscopes and consumables for sample preparation.

The proposed task builds on the existing activities under MASRI by developing a new direction in the research work of IO-BAS, related to the monitoring and evaluation of microplastics in the Black Sea.

SCIENTIFIC TASK 3:

- Assessment of pollution of seawater, biota and sediments. Improving knowledge of the sources, distribution and consequences of pollution of the marine environment.

Motivation

Pollution of the surface waters of the Black Sea poses a threat to the aquatic environment with consequences such as acute and chronic toxicity to aquatic organisms, accumulations in the ecosystem,





loss of natural habitats and biodiversity, as well as a danger to human health. Priority should be given to identifying the causes of pollution and addressing emissions at source in the most economically and environmentally efficient way. In this regard, a series of Directives (2000/60/EC, 2008/56/EC, 2008/105/EC, 2009/90/EC, 2013/39/EC) have been adopted, which EU Member States are obliged to comply with, with the ultimate goal of achieving Good Marine Environment (GHS).

The level of pollution in the western part of the Black Sea has not yet been well studied. There are sporadic data. There are no threshold values for pollutants in sediments off the Bulgarian Black Sea coast and for some physicochemical elements for quality by season. Several monitoring campaigns have been carried out within the meaning of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). The samples were taken by IOBAS, but the analyses were carried out in accredited laboratories in the country and abroad. Directive 2009/90/EC introduces the minimum and mandatory criteria that must be met by the analytical methods used for monitoring the quality of water, sediments and biota, as well as the rules for proving and presenting the quality of the results obtained. Directive 2013/39/EC introduces amendments to Directives 2000/60/EC and 2008/105/EC with regard to priority substances in the field of water policy, complementing the list of observed chemical pollutants with new substances and making the Environmental Quality Standards (EQS) more stringent. The complex matrix of seawater and the low limits of determination, which must be achieved in accordance with the EQS, require the use of the highest class of analytical equipment.

The main objective is to introduce a systematic study of quality physicochemical elements and chemical pollutants in various matrices of the marine environment in the western Black Sea (water, sediments and biota), as well as to create a basis for the analysis and assessment of marine pollution in support of the achievement of UN Sustainable Development Goal 14: Conservation and sustainable use of oceans, seas and marine resources for sustainable development.

Fundamental research is related to the development of methodologies or the application of ISO standards for the analysis of physicochemical quality elements, priority substances and specific pollutants. Conducting systematic studies to establish their concentrations in the marine environment and their impact on quality of life, health risk and ecosystem status.

In the applied aspect, the analysis and evaluation of the results obtained will serve the management bodies for the development of science-based strategies and programs for sustainable management and achievement of the GHMS, as well as for improving the qualification of scientists and researchers and providing a modern research infrastructure. Multidisciplinary partnership between research teams with different scientific orientations will be stimulated.

Specific tasks/activities

To achieve the main goal, the following tasks have been set:

1. Maintaining the accreditation already obtained under BDS EN ISO/IEC 17025:2018 and the possibility to expand its scope with an analysis of priority substances and specific pollutants.
2. Equipment Procurement, Installation, Commissioning and Training Procedures (**ICP-MS** - Inductively Coupled Plasma - Mass Spectrometry with Undiluted Sea Water Sampling System (**SC-2 Sea FAST SP3**) for Analysis of *Metals in Marine Waters, Sediments and Biota*, **GC-MS-MS-MS/P&T** - Head Space/Pepper & Trap Gas Chromatography - Mass Spectrometry and **HPLC** - High Performance Liquid Chromatography *for the analysis of organic pollutants*).





3. Introduction of methods for the analysis of priority substances and specific pollutants.
4. Review of existing practices and criteria in the EU Member States for the classification of hazardous substances by physicochemical, toxicological and ecotoxicological properties. Conducting sampling with a high degree of reliability. Applying analytical methods with the lowest possible limits of determination and obtaining results for the content of chemical pollutants with a high degree of confidence. Collection of initial data on pollutants in the water layer, sediments and biota and assessment of the level of their distribution in the environment and data on their production and use. Selection of an appropriate phase of the aquatic environment for monitoring (water, sediment, biota) for individual elements and compounds.
5. Identify pollutants with high potential for accumulation in sediments and background concentrations of metals and assess and determine their bioavailable concentrations. Lay the foundation and adopt an approach to assess long-term trends in changes in the concentrations of these pollutants in sediments and biota.
6. Application of an appropriate statistical approach to the processing of the results obtained; assessment of the level of contamination, enrichment and ecotoxicological level.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity is to Module *IV - Research Laboratory Complex, Marine Chemical Laboratory* and to Module *I - Research Fleet, Regional Class Research Vessel "Academic"*, Module II - *NOMOS* and Module III *Data and Information Center*

Scientific results and indicators

Challenge	Indicator	Number
1	Calibration of technical measuring instruments with which analyses are carried out in LI - annually	4
	Maintenance of the Milli-Q system for ultra-pure water in the determination of low levels of nutrients, preparation of reagents and solutions - annually	4
	Determination of nitrates and total nitrogen using an advanced peristaltic pump	24
	Determination of low-concentration nutrients and improved pH determination methodology using a high-resolution spectrophotometer	2
	Developed methodology for evaluation of FHEC	1
	Publications in international scientific journals with impact factor/refereed journals	3
	Trained PhD students/young scientists/specialists	3
2	Publications in international scientific journals with impact factor/refereed journals	3
	Participation in prestigious international scientific forums	5
	Developed/adapted methodology for analysis of microplastics in water, sediments and biota - methodological package	1
	Database on the distribution, quantity and characteristics of microplastics	1
	Improved monitoring programs under MSFD Descriptor 10 1-2 sentences	1
	Development of a new area in the Department of Marine Chemistry: microplastics	1
	Trained PhD students/young scientists/specialists	2
	Dissemination of results to the public	2
	Construction of the laboratory base	1
3	Publications in international scientific journals with impact factor/refereed journals	3





	Participation in prestigious international scientific forums	3
	Developed/adapted methodology for analysis of microplastics in water, sediments and biota - methodological package	1
	Database on the distribution, quantity and characteristics of microplastics	1
	Improved MSFD monitoring programmes	1
	Development of a new line of research (gas and liquid chromatography, atomic absorption)	3
	Trained PhD students/young scientists/specialists	3
	Dissemination of results to the public	2



2. Laboratory of Marine Biology and Ecology – IO-BAS

SCIENTIFIC TASK 1. Study of biodiversity of marine macrophytes (seagrasses and macroalgae) for the needs of national monitoring

Motivation

Marine macroalgae and grasses are an important component of coastal ecosystems. Macroalgae and seagrasses form the basis of the benthic food chain and provide important ecological functions such as providing a food base, oxygen and habitat for a number of marine organisms (mollusks, crustaceans, fish – including fishing sites such as gobies, mullets and garfish). In addition, seagrasses have a coastal protection function, and algae and grasses are involved in the purification and clarification of waters, which underlies their use as elements in the concept of "nature-based solutions" in coastal areas.

Grasses and algae are sensitive indicators of the impact of a number of stressors in the coastal zone: eutrophication, climate change, entry of non-native species, changes in hydromorphological conditions, sealing and direct, mechanical impact on the bottom, etc. That is why macroalgae and seagrasses are a mandatory element of the programs for monitoring and assessing the state of the coastal environment, according to the requirements of a number of European and international documents. Regular monitoring and assessment of their status is mandatory according to the European directives – the Water Framework Directive (2000/60/EC) and the Marine Strategy Framework Directive (MSFD). The requirements of both are transposed into the Water Act and the by-laws. Their habitats are subject to monitoring and assessment under the Habitat Directive, the requirements of which are enshrined in the Biodiversity Protection Act.

Monitoring of the marine environment is a legally defined obligation of the Institute of Oceanology at the Bulgarian Academy of Sciences, according to Art. 171 para. 2, item 3 of the Water Act (AA). The observations and assessments include sampling and analysis of the current state of a number of parameters, part of which are marine macrophytes.

Monitoring covers all sampling activities and subsequent laboratory and statistical analysis of the samples taken. Laboratory analysis activities include washing, sorting and microscopic determination of species, which requires specialized laboratory conditions. This creates the need to set up a specialized laboratory room, with sufficient working area and separate workplaces, meeting the requirements for macrophyte analysis.

Specific tasks/activities

- Laboratory analysis of macrophyte samples, in connection with the fulfillment of the obligations of the IO, according to the Environmental Protection Act.
- Preparation of databases containing the results of the analyzes carried out
- Preparation of scientific and applied reports.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity belongs to Module IV "Research Laboratory Complex", with the leading participation of the Laboratory of Marine Biology and Ecology.





The activity is also related to Module III 'Data and Information Centre', as the results should be organised in a structured database, compatible with future inclusion in national and international marine information systems. Spatial results can be used to map pollution, to analyse high-risk areas and to support management authorities.

SCIENTIFIC TASK 2. Development of the scientific foundations for determining the good condition of the bottom habitats in the Black Sea

Motivation

The protection of the integrity of the seabed and the biodiversity of benthic habitats is directly related to the so-called "blue growth". and in particular to sustainable development in the fisheries sector, while respecting the requirements of the green economy, which in this case consists in applying an ecosystem approach to fisheries management, ensuring that the pressures of this activity are within limits compatible with the achievement of good environmental status, and that the ability of marine ecosystems to cope with human-induced changes is not jeopardised, while at the same time allowing for the sustainable long-term use of marine products and services. The planned activities for the development of indicators and indicator systems will contribute to the development of methodological standards for assessing the state of the marine environment with regard to zoobenthic species of economic importance, bottom habitats and the integrity of the seabed. The developed indicators will help to assess the effectiveness of the MSFD Programme of measures, in particular fisheries measures, and in case of established failure to achieve the environmental objectives for the protection of the integrity of the seabed and economic species, they will be grounds for adapted management.

Specific tasks/activities

- Development of indicators and indicator systems to assess the adverse impact of physical disturbances on the Black Sea seabed and to determine the good state of the marine environment with regard to the integrity of the seabed, including the structure and functions of (species composition and relative abundance, absence of particularly sensitive or delicate species, or species providing important functions, dimensional composition of species) of bottom habitats and associated biological communities.
- Development of indicators and indicator systems for assessment of the state of the marine environment in relation to the economic species of shellfish in the Black Sea - *Donax trunculus*, *Chamelea gallina*, *Rapana venosa*: fishing mortality rate, breeding stock biomass, catch/biomass ratio by species, age and size structure of individuals in the populations.
- Development of indicators and indicator systems for assessing the state of the marine environment with regard to the invasive alien species *Rapana venosa*.

The following types of activities are envisaged:

(A) Field studies for the collection of in situ data on:

- The distribution, diversity of species and abundance of communities of demersal invertebrates in the sediments of the seabed;
- The distribution, abundance and population characteristics of the target shell species.

B) Laboratory analysis of the collected samples from the bottom invertebrate fauna.

C) Analysis of data on biological communities and population characteristics of the target species.

E) Analysis of data from EAFA's VMS fishing vessel monitoring system for quantitative and spatial assessment of the pressure from physical disturbances on the seabed from mobile bottom fishing gear.

F) Output of indicators and threshold values.

D) Presentation of the results at scientific forums.





- E) Publication of the results in scientific journals.
- F) Training of PhD students.

The main activity of which of the 4 modules envisaged (I, II, III, IV) also includes connection with the other modules, planned equipment or other infrastructure.

It provides for the reconstruction and modernization of the existing field and laboratory infrastructure.

The main activity belongs to Panel IV Research Laboratory Complex – Laboratory of Marine Biology and Ecology.

SCIENTIFIC TASK 3. Innovative automated approach for monitoring phytoplankton biodiversity in the Black Sea, based on imaging flowcytometry and regional library

Motivation

Phytoplankton biodiversity as a key primary producer is of paramount importance for the functioning of the marine ecosystem, while it is extremely sensitive to environmental pressures, such as anthropogenic eutrophication and global climate change, leading to dramatic changes in communities and blooms of harmful microalgae. Therefore, phytoplankton characteristics are used as reliable indicators of water status within the framework of various legislative directives. Phytoplankton monitoring is a key element in assessing the ecological status of the marine ecosystem and the quality of monitoring data is essential to track changes in the structure and development of the phytoplankton community. Conventional methods of phytoplankton analysis, including the presence of potentially toxic species, do not provide the necessary information for early diagnosis of flowering phenomena. Compensating for these shortcomings is achieved through the use of modern technological solutions, by integrating microscopic and flowcytometric approaches for phytoplankton observation into a single measurement system.

One of the most commonly used automated *in situ* tools is CytoSense (CytoBuoy, Netherlands). CytoSense enables the analysis of a wide range of particle sizes in water samples, enables the classification of phytoplankton groups based on their individual optical "fingerprints" and provides images of selected particles, which is useful for species identification of specific planktonic groups. The instrument is characterized by high productivity, having the ability to analyze up to 30 samples per hour.

The scientific task is directly related to the NPP "Environmental Protection and Reduction of the Risk of Adverse Events and Natural Disasters" and more specifically with the specific objectives "Risks to biodiversity and ecosystem functioning as a component of a sustainable and favorable living environment" and "Water quality (including groundwater and marine) and their impact on the quality of life, health risk and the state of ecosystems" and is in line with the thematic area of the ISSS "Industry for Healthy Life and Bio-Technologies", as well as with priority "blue" technologies and the application of new methods and technologies in the sustainable use of river and marine resources.

Specific tasks/activities

- Commissioning of the CytoSense system;
- Processing, analysis and standardization of the data obtained from the CytoSense system;
- Validation of automatic clustering by microscopic methods;





- Development and optimization of algorithms for classification of phytoplankton groups;
- Creation of a database and archive for long-term storage of the results obtained;

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity belongs to Panel IV Research Laboratory Complex – Laboratory of Marine Biology and Ecology.

Scientific results and indicators

Challenge	Indicator	Number
1	Database with the results of the monitoring carried out	2
	Creation of a new working environment for marine biological analyses with two separate workplaces, allowing the simultaneous work of two experts	1
	Equipment for <i>in-situ</i> observations of illumination underwater. Equipment with a miniature waterproof temperature and illumination recorder, optical base station and software, submersible loggers for recording photosynthetically active radiation (PHARE), a system with brushes and mounting brackets for automatic cleaning of PHARE sensors.	1 pc. (set)
2	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	2
	Develop methods: – to assess the adverse impact of physical disturbances on the seabed in the Black Sea; – assessing the state of the marine environment with regard to shellfish farms; – to assess the state of the marine environment with regard to the invasive alien species <i>Rapana venosa</i>.	3
	Trained PhD students (other specialists)	1
3	Database and archive for long-term storage of the results obtained;	1



3. Marine Geological Laboratory – IO-BAS

SCIENTIFIC TASK 1: Integrated geodatabase and analysis of geological and geomorphological conditions in the coastal zone and seabed

Motivation

The Bulgarian Black Sea coastal zone is a complex and dynamic system in which natural marine geological and anthropogenic processes interact, determining the spatial distribution, transport and accumulation of sediments. These processes form and transform key morphological elements such as beaches, dunes and the adjacent shallow seabed, which perform essential ecological, protective and socio-economic functions.

Despite the availability of a number of scientific studies, there is currently a lack of integrated, standardized and spatially consistent geodatabase integrating information on particle size distribution, morphology and dynamics of sediments in the beach-dunes-seabed system. Existing data are fragmented, often uncomparable and limited in spatial and temporal scope, which makes it difficult to carry out reliable analyses and long-term estimates.

This deficit limits the possibilities for targeted assessments of sediment distribution, change in their characterization, identification of areas with active erosion or accumulation, as well as for the development of science-based solutions for coastal zone management. In this context, the development of an integrated GIS-based geodatabase, combined with highly accurate data on the structure and composition of sediment, is a key prerequisite for improving the scientific understanding of the functioning of coastal systems.

The proposed scientific task is directly related to national priorities in the field of marine research, coastal zone protection and sustainable management of natural resources. It contributes to the implementation of UN Sustainable Development Goal 14, as well as to the implementation of the principles of maritime spatial planning and "blue growth".

Specific tasks/activities

The implementation of the scientific task includes the following main activities:

- Collection, analysis and systematization of available data on sediments in the coastal zone;
- Conducting field research and sampling from beaches, dunes and shallow seabed;
- Performing high-precision particle size analysis using a laser diffractometer;
- Determination of basic sedimentological parameters and statistical indicators;
- Creation and maintenance of a GIS-based geodatabase of sediments;
- Analysis of the spatial distribution and dynamics of sediments;
- Identification of areas with erosion, accumulation and loss of seabed.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity is carried out within Module IV – Marine Geological Laboratory, which acts as a central analytical component for sediment research.





In the laboratory, high-precision sediment analyses are carried out using the implemented laser diffractometer, which allows determining the distribution of particles by size in a wide range - from micron to millimeter fractions. The use of this system provides quantitative, reproducible and high-resolution characteristics of sediments, which is essential for the analysis of sediment transport and morphodynamics of the coastal zone.

The obtained data are integrated with the observation systems of Module II (NOMOS), providing information on waves, currents and sea level, as well as with the analytical and computational resources of Module III (Data and Information Center). This integration allows the creation of complex models for assessment of geological and geomorphological processes and their spatio-temporal dynamics.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	1
	Participation in prestigious international forums	1
	Map of marine sediments of parts of the coastal zone	1
	Marine Sediments and Beach-Dune Systems Database	1
	Trained PhD students and students in marine geology and geomorphology (preparation of dissertation or diploma theses)	2



4. Laboratory of Marine Genetics – IO-BAS

SCIENTIFIC TASK 1: Innovative methods for studying the population-genetic structure and refining the taxonomic affiliation of marine hydrobionts, directly related to the study of their biodiversity, the rational use of their stocks with a contribution to the development of aquaculture.

Motivation

Biodiversity is a major environmental priority of the EU and the related objectives are integrated into the strategy for its sustainable development. The use of genetic methods for analysis makes it possible to create a comprehensive picture of the biodiversity of fish and other aquatic organisms along the Bulgarian Black Sea coast. The establishment of the current state and distribution of hydrobionts is a prerequisite for determining adequate conservation measures for the conservation of existing populations. The discovered genetic markers can serve for future monitoring of the genetic structure of the populations of the studied species both in the marine environment and in aquaculture conditions. The future of the aquaculture sector consists in the conservation of genetic biodiversity and the maintenance of good aquaculture production lines.

The implementation of adequate monitoring of the population structure and biodiversity is a key element of the rational exploitation and conservation of fish populations. The development of molecular markers and the identification of the populations of industrial species of fish off the Bulgarian Black Sea coast will provide a stable basis for future monitoring of their stocks, which is essential for their sustainable exploitation. The results obtained can also be applied for genetic control of the parent flock and offspring in aquaculture breeding of economically valuable species and as a basis for sustainable development of this sector in our country. In this sense, the application of an innovative approach to the assessment and conservation of biodiversity and the population structure of economically valuable species is a contribution to the development of competitive aquaculture.

Phytoplankton biodiversity, as a key primary producer, is associated with fundamental processes determining the ecosystem's resilience to natural disturbances and anthropogenic pressures, a mandatory element in the European Marine Environment Quality Assessment Directives (Water Framework Directive, Marine Strategy Framework Directive). The development of toxic and flowering microalgae species can have a serious negative effect on human health and the environment and requires significant competences for the management of marine resources threatened by toxic phenomena in relation to bathing water quality (Directive 76/160/EEC), seafood safety and risk to human health.

The scientific task is directly related to the NNP "Environmental Protection and Reduction of the Risk of Adverse Events and Natural Disasters" and more specifically with the specific objective "Risks to biodiversity and ecosystem functioning as a component of a sustainable and favorable living environment".

The planned task is in accordance with the thematic area of ISIS "Industry for Healthy Life and Bio-Technologies", as well as with priority "blue" technologies and the application of new methods and technologies in the sustainable use of river and marine resources. The application of molecular-genetic methods to assess the population and genetic structure of exploited fish species is directly related to





the rational exploitation of fish stocks and the development of programs for their sustainable management. As fish resources are decreasing due to overfishing, the task being developed is in line with the strategy for "Blue Economy / Blue Growth" through the development of aquaculture, as a way to reduce the cumulative impact on living resources and water bodies. In this sense, the scientific task is directly related to one of the applied aspects of the NNP "Environmental Protection and Risk Reduction of Adverse Events and Natural Disasters" - Filling gaps in knowledge about the mechanisms of biodiversity loss ecosystem functions in Bulgaria and the Black Sea in the context of climate change and extreme natural phenomena and their interactions with local human activities; possible ways to mitigate the negative impacts and adapt to them.

Specific tasks/activities

1. Genetic screening and refinement of the taxonomic status of fish and other hydrobionts in which there is a problem with the exact species identification and their biodiversity;
2. Genetic screening of phytoplanktonic biodiversity, with an emphasis on identifying potentially toxic species;
3. Identification of stocks and assessment of genetic variability in economically valuable fish species off the Bulgarian Black Sea coast in a multiannual aspect.
4. Assessment of the impact of exploitation levels on the genetic diversity of commercially valuable marine fish species
5. Testing the feasibility of non-invasive methods for assessing the population-genetic structure of economically valuable fish species.
6. Enrichment of the world's genetic databases with data from the Black Sea.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity belongs to module IV Research Laboratory Complex – Laboratory of Marine Genetics.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	3
	Participation in prestigious international forums	3
	Enrichment of the world's genetic databases with data from the Black Sea	1
	Repair and retrofitting of the laboratory	1



5. Laboratory for Marine Living Resources – IFR

SCIENTIFIC TASK 1. Research on marine living resources, with a focus on industrially exploited shellfish

Motivation

The marine ecosystem of the Black Sea is under strong anthropogenic influence, including overfishing, habitat degradation, pollution and climate change. Among the important marine resources of ecological and economic importance are shellfish such as the rapana *Rapana venosa*, the black mussel *Mytilus galloprovincialis* and the sand mussels *Donax* spp., *Chamelea gallina*. Despite their importance as components of benthic ecosystems, filtering organisms and commercial fisheries, information on their spatial distribution, population dynamics and biological characteristics remains insufficient for effective resource management.

The invasive species *Rapana venosa*, which has a significant impact on local communities and populations of bivalve molluscs, requires particular attention. A comprehensive scientific assessment of the status of industrially exploited shellfish is needed to support the development and improvement of monitoring programmes and science-based measures for the sustainable management of living marine resources.

The purpose of the study is to assess the state of industrially exploited shellfish in the Bulgarian Black Sea waters by studying their distribution and biological characteristics, as well as by developing and improving a monitoring strategy. The main emphasis is placed on:

- spatial distribution and population dynamics;
- development and improvement of monitoring programs.

Use of information:

The study will contribute to expanding knowledge about the spatial distribution and biological features of key species of shellfish in the Black Sea under modern conditions. The results will improve the understanding of the status of *Rapana venosa* and local bivalve molluscs. The data obtained will complement information on living marine resources and the functioning of coastal ecosystems.

Practical significance: The study will provide scientific data on the status of industrially exploited shellfish molluscs, will support the updating of databases on the biological parameters of *Rapana venosa*, will contribute to the preparation of thematic maps of the distribution of the main exploited species, as well as the development and improvement of monitoring programs for shellfish on the Bulgarian Black Sea coast. The results obtained can serve as a scientific basis for the formulation of recommendations for sustainable management and conservation of marine living resources.





Specific tasks/activities

Task 1: Assessment of physicochemical and hydrobiological conditions in the areas of distribution of shellfish

Activities to achieve the goal and objectives:

- Conducting hydrochemical and hydrobiological observations.
- Measurement of key parameters: temperature, salinity, oxygen, nutrients, plankton and benthos.

Task 2: Determination of the quantity, spatial distribution and dimensional structure of populations of industrially exploited shellfish molluscs.

Activities to achieve:

- Studies on beam-trawl trawls in key fishing areas.
- Collection of data on abundance, biomass and dimensional and weight composition of the target species.

Task 3: Determination of basic biological parameters of key shellfish species

Activities to achieve:

- Laboratory analysis of samples, establishment of linear-weight dependencies.
- Determination of gender structure and linear-weight structure by gender.

Task 4: Geographic mapping

Activities to achieve:

- Statistical processing of data on size, biomass and distribution of species.
- Preparation of GIS maps of the spatial distribution.

Task 5: Preparation of scientific publications and analytical materials.

Activities to achieve:

- Analysis and interpretation of the results.
- Preparation of scientific publications and participation in international scientific forums.

Task 6: Develop and improve monitoring programmes on shellfish.

Activities to achieve the goal and objectives:

- Development of a monitoring strategy.
- Determination of indicators for assessing the status of industrially exploited shellfish molluscs.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity belongs to Module IV. Research Laboratory Complex and has a connection with other laboratories to Module IV - Marine Chemistry Laboratory, Marine Genetics Laboratory, Marine Living Resources Laboratory, Marine Medicine Laboratory.





1.4. Scientific results and indicators

Task 1.	Indicator	Number, for the entire period of the project
1	Publications in international scientific journals with impact factor	14
	Participation in international forums	13
	Making maps of the distribution of <i>Rapana venosa</i> in front of the entire Bulgarian coast for the following periods: summer seasons 2020-2026, and autumn seasons 2020-2024	6(summer)+4(autumn)/10 total
	Making maps of the distribution of <i>Donax spp.</i> and <i>Chamelea gallina</i> in front of the Bulgarian coast during the summer seasons of 2021-2022	4
	Implementation of scientific and applied tasks (2018 - 2026)	16
	Database on the biological parameters of <i>Rapana venosa</i> , according to data from the landings of the Bulgarian fleet	1
	Improved monitoring program on industrially important shellfish off the Bulgarian Black Sea coast.	1



6. Laboratory of Marine Medicine - MU

SCIENTIFIC TASK 1: Study of the complex response of the human body to the impact of various factors of the marine environment

Motivation

More and more professional and other activities are carried out in the marine environment and more and more people are engaged in it. The dynamics of external factors at sea is much greater than that on land. It is unusual for the human body and leads to physiological and psychological responses to adaptation. They take place in parallel and in a complex. The main activity is in the aspect of preventive medicine – increasing stress resistance, increasing safety at sea and improving the preparation of maritime professionals for action in crisis situations. This is a more appropriate medical approach than treating patients on the verge of illness or with existing disabilities. The research is in line with the growing focus on evidence-based medicine. The aim is to protect and preserve the physical and mental health of those who communicate with the sea. Practical significance: Improving the working conditions, sports, recreation, etc. of maritime professionals (+ athletes, vacationers, etc.), as well as developing methodologies for prevention and overcoming of water accidents with a reduction of medical damages from them. An introductory stage is the information provision and publicity of the activities carried out.

Specific tasks/activities:

- Study of the rapid, medium-term and time-stable adaptation mechanisms of humans under the influence of situations related to the marine environment.
- Covering the maximum number of options for maritime specialties and activities with a focus on maritime explorers and trainees for maritime professions.
- Anthropometric study of marine professionals sporting sea sports and residing for various reasons in the marine environment and along the coast.
- Functional studies of the systems in the body engaged in overcoming the adverse effects of the marine environment, including occupational ones – cardiovascular system, respiratory system, musculoskeletal system, etc.
- Reporting of physiological reactions in professional, sports, entertainment, transport, etc. loads of the human body in the marine environment.
- Experimental load and taking into account the body's abilities to overcome extreme situations.
- Study and study of the psychological and psychophysiological adaptive mechanisms of marine specialists.
- Study of psychophysiological changes in the cognitive, motivational and personal spheres in marine specialists occurring under the influence of the marine environment.
- Building a model of a structured algorithm for assessing the state of health, combining anthropometry, functional tests and psychophysiological studies in successive stages: 1) screening and incoming registration, somatoscopy/anthropometry, 2) functional test of target





organs and systems, 3) psychophysiological analysis and 4) generalized health profile aimed at early detection of health problems, risk assessment and planning of follow-up actions.

Activities to achieve the goal and objectives:

- Study of target groups.
- Description and analysis of the specifics of the impacts related to the marine environment on the human body.
- Attracting volunteers for the purpose of research through detailed information with a view to maximum and conscious cooperation on their part.
- Precise preliminary, follow-up, step-by-step and final (after the relevant experiment and/or situation) reporting of anthropometric indicators.
- Functional studies at rest, in a professional and extreme situation.
- Adaptation of new psychological methodologies to the needs of maritime professionals.
- Study of changes in sleep in marine specialists occurring during long-term physical and mental stress.
- Study of changes in the cognitive, motivational and personality spheres in marine specialists occurring during long-term physical and mental exertion.

The main activity to which of the envisaged modules/work packages also refers to connection with the other panels/work packages, planned equipment or other infrastructure

The participation of MU-Varna is in the IVth module "Research Laboratory Complex" with the construction of one of the laboratories - "Laboratory of Marine Medicine" and research activities based on it.

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	5
	Participation in prestigious international forums	5
	Development and defense of dissertations	2
	Development of a new scientific direction	2
	Trained by PhD students	2
	Trained students	100
	Conducting scientific forums	10
	Trainings, training courses	10
	Publication of monographs and teaching aids	8



7. Laboratory for Marine Renewable Energy Resources – BSHC

SCIENTIFIC TASK 1. Study of the dynamics of floating bodies in real marine conditions

Motivation

Blue growth is a long-term strategy to support industry in the maritime sector. It identifies the seas and oceans as a driving force for the European economy with great potential for innovation and growth. It also helps the Integrated Maritime Policy to achieve the Europe 2027 goals of smart, sustainable and inclusive growth. Blue energy refers to all forms of use of renewable marine and ocean energy - wave, current, tidal energy, as well as offshore wind energy and related technological developments.

The study of blue energy sources and the development of technologies for its production is about to become a major pillar of the European energy policy according to the ESET (European Strategic Energy Technology Plan) developed by the European Commission back in 2007. The project activities are aimed at studying the interactions of marine engineering facilities with the environment (currents, waves, rigid boundaries, etc.) and creating opportunities for improving their performance through complex studies with theoretical and experimental methods. Particular attention is paid to mathematical modeling with the application of computational hydrodynamics methods, as well as to the processes related to the operation of new types of non-standard facilities.

This research strategy finds its foundations in the Cohesion Policy of Europe 2014-2020 for the development of a national/regional research and innovation strategy and corresponding infrastructure through which to achieve policy support and investments in technological innovations and experimentation in key priorities, challenges and needs for the development of national economies. This policy has been implemented in particular in the field of the maritime industry through the creation of the European Technology Platform ECMAR, in which Central Chan-Varna is an active participant, and is accordingly reflected in the Strategy for Research in Bulgaria (2017-2030) under the generalizing theme "clean technologies".

Specific tasks/activities:

Performing numerical and experimental studies on:

- ✓ Numerical model of Wave Channel (VC);
- ✓ CFD calculations, structural design data and calculation of the drive capacities of the VC wave product;
- ✓ Conceptual design of a wave producer for a small VC;
- ✓ Technical design of a wave product for a small VC;
- ✓ Methodology for creating water currents with the necessary parameters of the velocity profile in the small wave channel;
- ✓ Methodology for experimental determination of the efficiency of different types of wave extinguishing systems;
- ✓ Formulation of a mathematical approach to describe fluid flow when flowing around a cylinder near a free surface;
- ✓ Determination of the parameters that lead to loss of flow stability and by which the development of bifurcation can be traced;





- ✓ An innovative method to increase the energy efficiency of the ship by using the energy of the ship's wobble on waves.

The main activity of which of the envisaged modules/work packages (I, II, III, IV) also includes connection with the other panels/work packages, planned equipment or other infrastructure

The main activity belongs to Module IV - Laboratory for Marine Renewable Energy Resources.

Scientific results and indicators

Challenge	Indicator	Number
	Publications in international scientific journals with impact factor	2
	Trained PhD students (other specialists)	5
	Participation in prestigious international forums	6



8. Laboratory of Underwater Technologies – Naval Academy

SCIENTIFIC TASK 1. Developing, testing and implementing innovative underwater technologies, safety standards and marine engineering systems.

Motivation

The exploitation of marine resources and the maintenance of underwater infrastructure require the creation of highly specialized laboratory capacity. The Laboratory of Underwater Technologies at the Naval Academy will provide a modern base for research and development in the field of underwater robotics, acoustic sensor systems and diving technologies. In addition, in response to the global goals for decarbonization of shipping, the laboratory will develop research activities focused on marine engineering, synthetic fuels and the processes of integration of hydrogen technologies in the marine industry.

Specific tasks/activities

- Design, laboratory testing and calibration of remotely operated underwater vehicles (ROVs) and underwater monitoring systems;
- Development of standardized diving documentation;
- Performing engineering analyses and laboratory studies related to the production of synthetic fuels and the implementation of hydrogen fuel systems in offshore platforms;
- Simulating underwater operations for the needs of the marine industry and testing diving equipment.

The main activity of which of the 4 modules envisaged (I, II, III, IV) also includes connection with the other panels, planned equipment or other infrastructure

The laboratory is a major component of Module IV "Research Laboratory Complex" and works in close integration with Module I (Boat for Underwater Research and Technological Operations - Naval Academy), as well as with the Laboratory of Underwater Cutting and Welding (TU) and the Laboratory of Marine Medicine (MU).

Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	1





9. Laboratory for Diagnostics of Ship Structures and Equipment - TU

SCIENTIFIC TASK 1. Diagnostics of ship structures and equipment

Motivation

Technical University - Varna is a member of the consortium and respectively a partner in the implementation of a project of the National Roadmap (2020-2027) for scientific infrastructure: "Infrastructure for sustainable development in the field of marine research, and participation of the Republic of Bulgaria in the European infrastructure Euro-Agro - (MASRI)".

The participation of the Technical University of Varna in the project is related to the creation of a laboratory complex for marine research in the part of the laboratory "Diagnostics of Ship Structures and Equipment" (SCC).

The establishment of the laboratory for diagnostics of ship structures and equipment is directly related to the "blue economy", one of the main priority areas for the EU Member States, regions, enterprises and civil society. The construction of the laboratory is in line with the strategy of the Technical University - Varna for research: marine scientific technologies to ensure blue growth and sustainable development.

It is envisaged that the laboratory of "Diagnostics of ship structures and equipment" will be equipped with the most modern research equipment for diagnostics of ship structures in order to increase the efficiency and reliability of the operation of marine facilities, as well as to minimize the impact on the environment.

Specific tasks/activities

It is envisaged that the laboratory will carry out activities in the field of:

- Experimental study of the static and dynamic stressed and deformed state of machines and equipment, as well as of the noise emitted in the environment during operation;
- Vibration control and diagnostics of machines and equipment;
- Development of technical solutions to improve the vibration condition of machines and equipment, limit noise impact, ensure reliable and environmentally friendly operation.

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity refers to Module IV "Research Laboratory Complex" in the part for the Laboratory for Diagnostics of Ship Structures and Equipment. In Module I "Research Fleet" there is a connection with the vessels planned for construction in the project.





Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	1
	Development of a methodology for the design of the anti-noise and anti-vibration complex of the ship	1
	Trained PhD students (other specialists)	1



10. Laboratory of Underwater Cutting and Welding - TU

SCIENTIFIC TASK 1. Underwater welding and cutting technology

Motivation.

The Technical University of Varna is a member of the consortium and respectively a partner in the implementation of a project from the National Roadmap (2017-2023) for scientific infrastructure: "Infrastructure for sustainable development in the field of marine research, also linked to the participation of the Republic of Bulgaria in the European Infrastructure (Euro-Argo)-(MASRI)".

The participation of the university in the project is related to the creation of a laboratory complex for marine research. Practice shows that underwater welding technologies need research related to laboratory and full-scale tests, as well as training of qualified personnel (divers). This requires the laboratory to have the necessary infrastructure (deep-sea basin) for training and experimental activities. The training also requires qualification and experimental activity of operators in marine conditions, which is related to the use of vessels.

Specific tasks/activities.

The tasks that the laboratory will solve are as follows:

- Scientific research related to the creation of technologies for underwater cutting and welding of metals;
- Production and implementation of equipment and technologies related to underwater welding processes;
- Creation of a training center for divers to work underwater with specialized welding equipment;

Which of the 4 modules envisaged (I, II, III, IV) also includes connection to the other modules, planned equipment or other infrastructure

The main activity refers to Module IV in the part for the Underwater Cutting and Welding Laboratory. In Module I, "Research Fleet", there is a connection with the Boat part for underwater research and technological operations. There is also a connection with other laboratories from Module IV: Laboratory of Underwater Technologies, Laboratory of Marine Medicine, Laboratory of Diagnostics of Ship Structures and Equipment.





Scientific results and indicators

Challenge	Indicator	Number
1	Publications in international scientific journals with impact factor	2
	Participation in prestigious international forums	2
	Built system for forecasting the parameters of welding and cutting modes under water	1
	Developed methodology for studying the processes of electro-oxy cutting of metals under water	1
	Development of a new line of research (underwater welding technologies)	1
	Trained PhD students (other specialists)	2
	New disciplines of study	1